Remarks

Claims 1-20 are pending in the application. Claims 1-20 are rejected. Claims 8, 10, 11, 13, 14, and 17-20 are amended herein. No new subject matter is added.

Claims 8, 10, 11, 13, 14 and 17-20 are amended herein to correct clerical errors resulting from a claim numbering error in the originally filed application. In the rejection, the Examiner referred to the claims using the correct numbering. This amendment reflects the correct numbering of the claims as well.

Claims 1-20 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention.

The Examiner clarified his 35 U.S.C. 112 rejection in an interview summary mailed on August 25, 2004. In his darification, the Examiner asserts that the claim language "the 3D model including a linear basis for deformable shape of the object in the video, and for each image a 3D rotations matrix, deformation coefficients, and translation vectors," makes the claim vague.

In support of his assertion, the Examiner erroneously states "The reading of the claim as being "linear basis for the deformable shape" in the video contradicts the next half of the reading of the claim where the claim requires "deformation coefficients and translation," because to require the deformation coefficients the 3D model does not have the "linear basis" between the transformations. If there is a linear transformation then there is no deformation coefficient, or if there is

deformation coefficient then there is no linear transformation."
It is respectfully submitted that the Examiner's assertions are wrong. As described in detail in the specification, deformation and translation of the model are linear operations. For example, at page 7, lines 1-2, "the 3D model including a linear shape matrix **S**, and for each frame a 3D rotations matrix **R**, a deformation coefficients **c** vector, and a translation vector **T**." The Examiner is requested to explain exactly what is non-linear about a vector.

It would be readily understood to a person of ordinary skill in the art that a vector has a direction and a magnitude. Deforming a model of an object by moving a point some distance in the direction of the vector is a linear transformation. The Examiner's statement "If there is a linear transformation then there is no deformation coefficient, or if there is deformation coefficient then there is no linear transformation," is demonstrably false. Therefore, the Examiner is requested to reconsider and withdraw his rejection based on 35 U.S.C. 112, second paragraph.

Claims 1-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Irani, et al. ("Factorization with uncertainty," ECCV 2000 – "Irani"), in view of Baxes (Digital Image Processing, John Wiley & Sons, 1994 – "Baxes").

In independent claims 1, 15 and 16, the invention recovers non-rigid 3D shape and motion of an object from a video of the object. Correspondences of a set of features on the object in each image of the video are determined. The correspondences are factored into a motion matrix and a shape matrix. A 3D model is extracted from the factored motion matrix and the shape matrix that conforms to the object in the video. The 3D model includes a linear basis for deformable shape of the object in

the video, and for each image a 3D rotations matrix, deformation coefficients, and translation vectors.

Irani describes a way to deal with noise when modeling shape of a rigid object, see Introduction, page 539, below:

> covariance-weighted squared-error (or the *Mahalanobis distance*). In this paper, we describe a new approach to covariance-weighted factorization, which can factor noisy feature correspondences with high degree of directional uncertainty into structure and motion. Our approach is based on transforming the raw-data into a covariance-weighted data space, where the components of noise in the different directions are uncorrelated and identically distributed. Applying SVD to the transformed data now minimizes a meaningful objective function. We empirically show that our

Irani describes factoring noisy feature correspondences to produce the model of a rigid object. There is no mention of a deformable shape in Irani. Irani models rigid objects only. The Examiner admits that Irani fails to describe the 3D model includes a linear basis for deformable shape of the object in the video, and for each image a 3D rotations matrix, deformation coefficients, and translation vectors as claimed.

However, the Examiner points to the affine transformation described by Irani at page 541 and asserts "the rotation, the translation and the scaling of the image i.e. the deformation, is considered in recovering the 3D model." However, an object is not deformed if it is rotated, translated or scaled. The claimed 3D model includes a ***linear basis for deformable shape*** of the object in the video, and for each image a 3D rotations matrix, ***deformation coefficients***, and translation vectors. A person of ordinary skill in the art would readily understand that rotation, translation, scaling and affine transformation have nothing to do with deformation.

Rotation, translation and scaling strictly *maintain* the surface contour or shape of an object. Deformation, by definition, *alters* the surface contours of an object. For

example, the applicant respectfully requests the Examiner to consider an object such as a plastic coffee cup sitting on a table. If the cup is rotated, i.e., turned to face a different direction, no deformation has occurred. The shape of the model is unchanged. If the cup is translated, i.e., moved sideways to a different position on the table, no deformation of the shape has occurred. If the cup is scaled, i.e., shrunk or enlarged, no deformation of the shape has occurred. The model still has the identical surface contours of a cup. However, if the handle or rim is bent, then the cup is deformed, because now it has a different shape, i.e., the surface contours of the cup has changed.

A person of ordinary skill in the art would also understand that an affine transformation is any transformation that preserves collinearity, i.e., all points lying on a line initially still lie on a line after transformation, and ratios of distances, e.g., the midpoint of a line segment remains the midpoint after transformation. Irani uses an affine transformation for scaling, which never deforms an object.

Baxes describes operations such as translation and rotation performed on 2D image pixels. Baxes 2D operations cannot be combined with Irani's 3D rigid model. Further, claimed is a 3D model including a 3D rotations matrix, deformation coefficients, and translation vectors. For each image in the video, ***the 3D model*** can be rotated, translated and deformed to project the desired image. The claimed 3D rotations matrix, deformation coefficients, and translation vectors are applied to the ***3D model including a linear basis for deformable shape of the object*** in the video. Baxes describes 2D operations on images to produce images. Therefore, Baxes can never be used to make the invention obvious. Baxes is irrelevant to Irani and the invention.

The Examiner's rejections of claims 2, 3, 6, and 8-14, are utterly unsupported and should be reconsidered and withdrawn. The entire text of the examiner's rejection follows:

> "With respect to claims 2-3, 6, 8-14 as best understood, the Irani discloses the limitations as claimed in sections 1-4, the limitations are simply bring the procedure of SVD transformation, SVD factorization and the covariance, and are often used in the art."

First, it should be noted that the sentence itself makes no sense grammatically or semantically. The Applicant should not be required to attempt to interpret a nonsensical statement by the Examiner. Second, these assertions are nothing more that an omnibus rejections and provides no reasonable level of understanding of the basis for the Examiner's position. As recognized in MPEP 707.07(d), "omnibus rejection of the claim ...is usually not informative and should therefore be avoided." MPEP 707.07(f) further mandates that "where a major technical rejection is proper, it should be stated with a full development of the reasons rather than by a mere conclusion coupled with some stereotyped expression." The rejection by the Examiner is a mere conclusion, without a full development of reasons. Not a single element of the claims is addressed.

Claims 4-5 and 7 appear to be rejected as design choices in view of the combination of Irani and Baxes. However, as stated above, neither Irani nor Baxes, alone or in combination, describes, teaches, suggests or shows what is claimed.

Claims 17-20 are rejected for the same reasons as claims 2-14. Therefore, the Applicant asserts that those rejections are also mere conclusion, without a full development of reasons.

All rejections have been complied with, and applicant respectfully submits that the application is now in condition for allowance. The applicant urges the Examiner to contact the applicant's attorney at phone and address indicated below if assistance is required to move the present application to allowance. Please charge any shortages in fees in connection with this filing to Deposit Account 50-0749.

Respectfully submitted,
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